Seasonal fibre growth patterns in three breeds of down goat

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ABSTRACT

Fibre growth measurements were collected on feral (F) does, cashgora (G) and G4 does. Maximum and minimum down length occurred in early August and late November in all breeds. The down fleece shed between these dates. Maximum down length was 6.7±0.2, 9.7±0.2 and 15.0±0.3 cm in F, G and G4 does respectively ($p<0.001$). Down growth was at a maximum in March and a minimum in September in all breeds. The mean maximal down growth was 0.9±0.2, 1.3±0.2 and 4.1±0.2 mg/cm2 /week (mcw) ($p<0.001$) in F, G and G4 does respectively.

Maximum guard hair length occurred in August for all breeds whereas minimum length occurred in November for G4 does and January for F and G does ($p<0.001$). G4 does had a shorter ($p<0.01$) maximum guard hair length (5.9±0.1 cm) than either F or G does (6.5±0.1 cm). Guard hair growth was at a maximum in January in all breeds. G does (2.2±0.3 mcw) and F does (2.0±0.2 mcw) had a similar maximum guard hair growth. G4 does (0.8±0.3 mcw) had a lower maximum growth ($p<0.01$).

There was a biannual cycle of fibre diameter change in F and G does. Minimum fibre diameter occurred in January to March and again in August for F and G does. Periods of high fibre diameter occurred in November to December and again in May. G4 does had an annual cycle of fibre diameter change with a minimum in December and maximum in March. G4 does (23.0±0.3 micron) were coarser in mean down fibre diameter than G does (18.7±0.3) which were coarser than Feral does (17.5±0.3) ($p<0.01$). Fibre diameter distribution was similar for F and G does. G4 does had an extended range of fibre diameter distribution.

Keywords: Feral, G4, cashgora, length, diameter, weight.

INTRODUCTION

Fibre growth is cyclical in most goats with seasonal patterns of fibre growth being more pronounced in cashmere-producing goats than Angora goats. The cashmere goat has two distinct fleece types: a hair fleece (guard hair) which is shed and replaced simultaneously and therefore present throughout the year; and a down fleece which grows in the summer through to autumn and is shed in the spring. The down fleece is shed 1-3 months before new down fibres become visible in the fleece. The mechanism for the shedding of down is unknown. However a subsidiary spring cycle of down growth has been identified (Betteridge *et al.*, 1988) where new down fibres grow and shed shortly after in early summer.

Angora goats have a fleece which is continuously replaced but still retains seasonal fluctuations growing faster in summer than winter (Margolena, 1974). Angora goats have been crossed with cashmere goats to produce the new fibre cashgora and to improved down weights in cashmere goats (Gretton and Bigham, 1984). These goats have a guard hair and down fleece but little is known of their fibre growth cycle. Optimum shearing times, therefore are unknown. Personal observation would suggest that these goats grow down earlier and shed later than cashmere goats. Relative to the cashmere fleece the down fleece of the cashgora goat has a higher mean fibre diameter and an extended fibre diameter distribution. This presents potential processing problems in dehairing the cashgora fleece (Couchman, 1985).

The objective of this experiment was to determine whether there are differences in timing, magnitude, and quality of fibre growth in three breeds of down goats with varying proportions of Angora genes. This information will be used to define shearing times for the different breeds.

MATERIALS AND METHODS

Fibre growth measurements (Table 1) were collected on 75 cashmere producing Feral (F) does with no known Angora influence, 75 Cashgora (G) does with no more than 1/4 Angora genes and 75 G4 does with 1/2 Angora genes. All does were two years of age or older. The experiment was conducted at Flock House Agricultural Research Centre, AgResearch, Bulls from August 1990 to December 1991. Normal farm practices were used. All does were run with the buck in the 1990 breeding seasons. Kids were tagged and dam tag recorded within 24 hours of kidding. G4 does had been shorn one month prior to the start of the experiment but goats were not shorn during the experiment.

Mean length of guard hair and down was measured monthly at four sites (neck, front shoulder, midside and hind shoulder) on each goat. A ruler was placed onto the skin of the goat and the staple lying above the ruler was gently stretched and the length of the longest fibre recorded.

Fibre samples were clipped monthly from 30 goats per breed. The sample was clipped using "Oster animal" clippers (size 40 blade) on the right side of the animal from a 5 cm square within a 15x15 cm grid. The initial sampling sequence

TABLE 1: Number of goats per breed sampled and experimental schedule for fibre measurements.

Fibre Measurement	Sampling frequency	No. of goats sampled per breed
Down length	Monthly	75
Fibre Diameter Distribution	Bimonthly	30
Fibre diameter	Monthly	10
Midside growth	Bimonthly	10
Fibre eruption	Monthly or Two weekly	10

was randomly selected for each goat and thereafter the adjacent square was sampled. Down fibre diameter measurements were made on monthly samples from 10 goats per breed and bimonthly samples from 30 goats per breed. Two thousand fibres (cut-off point 80 microns) were measured using a Fibre Fineness Distribution Analyzer (Lynch and Michie, 1976). Mean fibre diameter of fibres less (down) and greater (intermediate) than 40 microns were calculated. Mean fibre diameter of fibres greater than 80 microns (guard hair) were measured on monthly samples. Three hundred fibres were measured using a computerised projection microscope in 10 goats per breed. Midside patches were clipped bimonthly from a measured area on 10 goats per breed. The fibre regrowth was weighed, subsampled and manually dissected into cashmere and guard hair. Fibre growth rates (mg/cm^2/week) of each fibre type were calculated.

Skin biopsy samples were taken from the 10 goats per breed at monthly intervals between July and January. Fortnightly skin samples were collected from September to November. The surface hairs of the skin sample were trimmed to 5 mm and viewed under a dissecting microscope (Table 2). The skin samples were scored. The scoring system was based on the presence of intact cashmere fibre tips. Newly erupted cashmere fibres are fibres of less than 3 mm in length which have an intact fibre tip. While short cashmere fibres have an intact fibre tip but are between 3 and 5 mm in length. Cashmere fibres which have been cut are scored as long cashmere.

TABLE 2: Scoring system for cashmere fibres based on presence of intact fibre tip.

Score	Description
1	newly erupted down fibres + long cashmere
2	newly erupted down fibres only
3	newly erupted down fibres + short cashmere
4	short cashmere only
5	short + long cashmere
6	long cashmere only

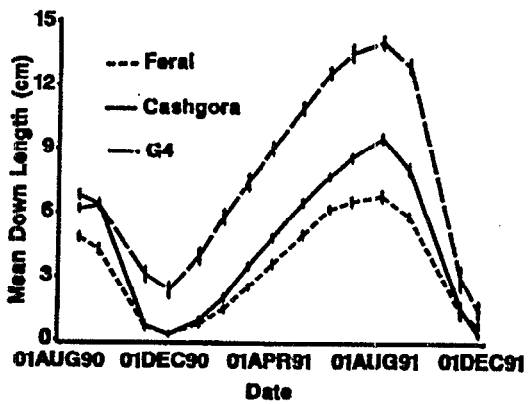
Statistical Analysis

The time at which maximum and minimum growth was achieved was compared for the three breeds. As was the time interval between the maximum and minimum growth (duration). The quantity of fibre growth was compared between breeds using maximum and minimum growth. In addition the difference between maximum and minimum growth (magnitude) was compared. Values were obtained for each individual goat for each of these parameters. General linear models (SAS) were used to compare the breeds for each of these parameters.

RESULTS

Kidding began mid-September and ended at the beginning of November 1991. An equivalent number of does from each breed kidded. No fibre measurements were taken during the kidding period.

FIGURE 1: Mean down length of feral, cashgora and G4 does.

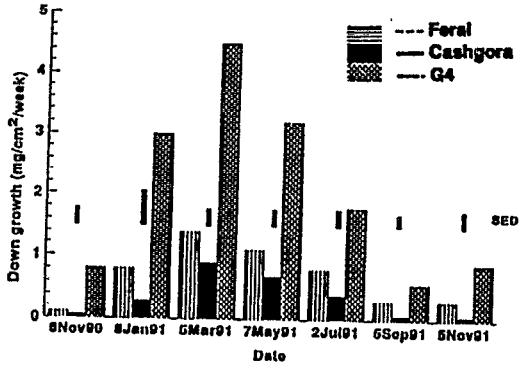


Fibre Growth

The maximum down length of G4 does was 15.0±0.2 cm compared to the G does with 9.7±0.2 cm and the F does with 6.7±0.3 cm ($p<.001$) (Fig 1). F and G does had a similar minimum down lengths of 0.2±0.2 cm and 0.1±0.2 cm respectively while G4 does were higher at 1.5±0.2 cm ($p<0.001$). The magnitude of down length growth of F, G and G4 does was 6.5±0.3 cm, 9.6±0.2 cm and 13.5±0.2 cm respectively ($p<0.001$). The down length cycle followed the same pattern for all breeds with maximum down length occurring in August and minimum down length occurring in November. The average duration of down length growth of 268±2 days was comparable for all three breeds. G4 does had the greatest overall mean down growth rate of 4.1±0.2 mg/cm^2/week (mcw) ($p<0.001$). F and G does had similar mean down growth rates of 0.9±0.2 mcw and 1.3±0.2 mcw respectively. There was no difference in the duration of the down growth cycle with maximum and minimum down growth occurring in March and September respectively for all breeds (Fig 2).

The F and G does had similar minimum guard hair lengths (3.1±0.2 cm) and maximum guard hair lengths (6.7±0.2 cm). G4 does had a lower minimum (2.7±0.2 cm) and maximum (5.9±0.2 cm) guard hair length than F or G does ($p<0.05$). There was no difference between breeds in the magnitude of the guard hair length cycle. The duration of the guard hair length cycle was similar between F (239±7 days) and G (251±7 days) does but longer ($p<0.001$) in G4 does (278±8 days). F and G does grew comparable quantities of guard hair (2.1±0.3 mcw) while G4 does (0.8±0.3 mcw) grew

FIGURE 2: Mean down growth of feral, cashgora and G4 does.



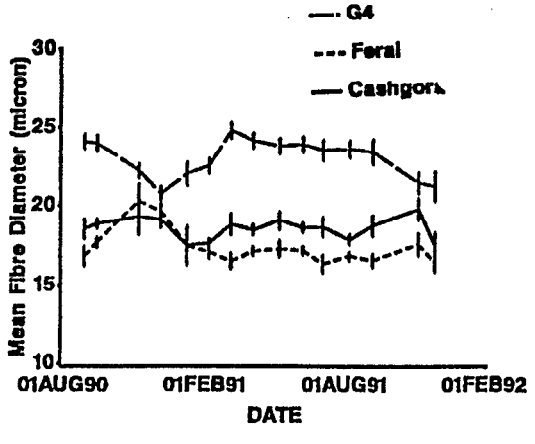
less guard hair (0.8±0.3 mcw) ($p>0.001$). The duration of guard hair growth cycle was shorter for F does (187±10 days) than the G (224±11 days) and G4 does (240±11 days) ($p<0.01$).

Newly erupted down fibres could be identified in all F and G does but in only 64% of the G4 does. The mean date of first presence of newly erupted down fibres was 23 days earlier in F does (28 September) compared with G4 does (30 October) ($p<.03$). G does were intermediate (6 October). The mean date of disappearance of newly erupted down fibres was December in all breeds.

Fibre Quality

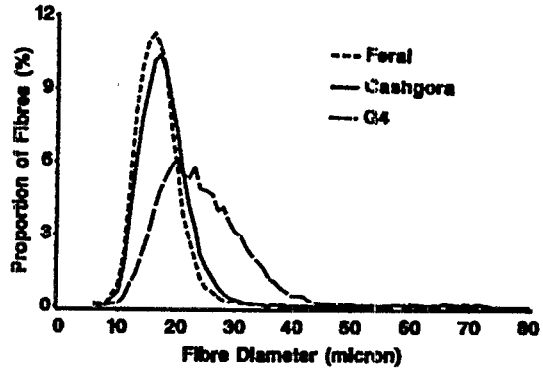
Down fibre diameter differed in all three breeds. G4 does had the coarsest overall mean down fibre diameter (23.0±0.3 micron), F the finest (17.5±0.3 micron) and G does (18.7±0.3 micron) were intermediate ($p<0.001$) (Fig 3). F and G does had a biannual down fibre diameter cycle with minima in January to March and again in August and maxima in November to December and again in May. G4 does had an annual cycle with a minimum in December and maximum in March. The mean guard hair fibre diameter in G4 does (77.2±4 micron) was finer than F and G does (104±4 micron) ($p<0.001$).

FIGURE 3: Mean down fibre diameter of feral, cashgora and G4 does.



F does had a higher percentage of cashmere fibres than G and G4 does (Fig 4). The fibre diameter distribution of the G does was similar to the F does but tended to have more intermediate fibres. G4 does had an extended fibre diameter distribution with a higher percentage of intermediate fibres than F or G does.

FIGURE 4: Fibre diameter distributions for feral, cashgora and G4 does.



DISCUSSION

Quantity differences in fibre growth were seen between the three breeds. G4 does had a much greater down length and down growth rate than G and F does and down length was also greater in G compared with F does. G4 does also had a longer minimum mean down length giving rise to the illusion of an extended growth cycle.

The duration of the down growth cycle was similar in all breeds with minimum down length occurring in November and the maximum in July. The duration and timing of the fibre growth cycles of the F goats in the experiment were similar to those reported by Mitchell et al.,(1989). The extended down growth cycle observed in the field, was not evident in this experiment. There was a difference in breeds in the guard hair growth cycle and a difference in the presence in newly erupted down fibres was also detected. Further studies of follicle activity will be required to finally confirm the hypothesis that breed of down goat has no effect on the timing of down growth.

As in other studies (Couchman, 1984) the infusion of Angora genes into cashmere goats has increased mean fibre diameter and increased the proportion of intermediate fibres within the down fleece. McDonald et al., (1987) observed a biannual fibre diameter cycle. F and G but not G4 does had a biannual fibre diameter cycle. The lower fibre diameter prior to shedding reflects the decline in growth rate prevailing at this time (Henderson and Sabine, 1992). The subsequent increase in fibre diameter after shedding could be explained by the loss of the finer fibres during shedding.

Couchman (1985) showed that the fibre diameter distribution of G is extended with two peaks, the first in the accepted cashmere range and the second in the super fine mohair range. The G4 does in this experiment showed the same extended fibre diameter distribution. The G and F does had similar fibre diameter distributions with the G does having only a slight displacement towards the coarser microns. The extended fibre diameter distribution in combination with the decrease in guard fibre diameter seen in the G4 does may create processing problems. Effective removal of the guard hair (dehairing) from the down fleece requires a 4

fold fibre diameter difference between guard hair and down (Tucker, 1985). F and G does had similar fibre diameter distribution and guard hair fibre diameter. Therefore dehairing efficiency should be similar in the two breeds.

In summary this experiment showed that increasing Angora ancestry results in an increase in down length, down growth, fibre diameter and fibre diameter distribution. Whereas guard hair length and growth is decreased with increasing Angora ancestry. The duration and timing of the gross down growth cycle is independent of Angora influence. However the guard hair growth cycle was extended by Angora influence. The subsidiary spring cycle of down growth was less evident in the G4 goats.

Optimum shearing time is a fine balance between maximum production and climatic conditions. Cashmere goats are traditionally shorn from June to August when down length and fibre diameter are optimum. Angora and cashgora goats are shorn twice a year in summer and late winter. The lack of major differences in the timing of the growth cycles between the breeds in this experiment would suggest cashgora goats should be shorn at the same time as cashmere goats.

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REFERENCES

Betteridge K, Gumsey M.P., Mitchell R.J., Nixon A.J., Welsh R.A.S., 1988. Growth of fibre in cashmere producing goats. *Sheep and Beef Cattle Society, New Zealand Veterinary Association 18th Annual Seminar, Lincoln College.*

Couchman R.C., 1984. Specification of fibre diameter profiles for Australian goat down. *Animal Production in Australia* **15:** 309-312.

Couchman R.C., 1987. *G. Proceedings Cashgora Goat Society. Western Australia:* 49-66.

Gretton S., Bigham M.L., 1984. Fibre production from progeny of (Angora x F) x F and F x F matings. *First Annual Goat Research Workshop, Melbourne University,* 25-28.

Henderson M. and Sabine J.R., 1992. Seasonal variation in the mitotic activity of secondary fibre follicles in adult cashmere goats. *Small Ruminant Research* **6:** 329-345.

Lynch L.J. and Michie N.A., 1976. An instrument for the rapid automatic measurement of fibre fineness distribution. *Textile Research Journal* **46:** 653-660.

Margolena L.A., 1974. Mohair histogenesis, maturation and shedding in the Angora goat. Technical Bulletin No. 1495. United States Department of Agriculture 1-7.

McDonald B.J., Connell J.A., Hoey W.A., 1985. Physiological research into cashmere production. *Progress report to Kinross Cashmere Company:* 3-6.

McDonald B.J., Hoey W.A., Hopkins P.S., 1987. Cyclic fleece growth in cashmere goats. *Australian Journal of Agricultural Research* **38:** 597-609.

Mitchell R.J.; Betteridge K., Welch R.A.S., Gumsey M.P., and Nixon A.J., 1989. Fibre growth cycles of unselected, reproducing cashmere does discussed in relation to winter shearing. *Proceedings of the New Zealand Society of Animal Production* **49:**163-164

Norton B.W., 1991. Management of Australian cashmere goats for maximum fleece growth. *Proceedings Cashmere Research Seminar, May 1991:* 28-41.

Tucker D.J., 1985. The non-protein components of the cashmere fibre. *Proceedings of the 7th International Wool Textile Research Conference, Tokyo.*